Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 17 (2): 655–667
https://doi.org/10.15560/17.2.655

PENSOFT

New records of vascular plants for the flora of Lebanon: a rare species rediscovered after seventy years, *Daphne pontica* L. (Thymelaeaceae), and three new occurrences, *Atropa bella-donna* L. (Solanaceae), *Circaea lutetiana* L. (Onagraceae), and *Euonymus latifolius* (L.) Mill. (Celastraceae)

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Abstract

During a series of surveys in two valleys of Mount Lebanon between 2014 and 2020, four new occurrences of vascular plants were detected. *Atropa bella-donna* L. (Solanaceae, Spermatophyte), *Circaea lutetiana* L. (Onagraceae, Spermatophyte), and *Euonymus latifolius* (L.) Mill. (Celastraceae, Spermatophyte) were recorded for the first time in Lebanon, while *Daphne pontica* L. (Thymelaeaceae, Spermatophyte), thought to be extirpated in Lebanon was rediscovered after 70 years. The updated distribution and ecology of these four Euro-Siberian elements, relics of the Quaternary glaciations, are presented.

Keywords

Eastern Mediterranean, Euxinian and Hyrcanian provinces, Euro-Siberian region, glacial refugium, Levant, relict plant species, SW Asia

Academic editor: Robert Philipp Wagensommer | Received 31 December 2020 | Accepted 30 March 2021 | Published 14 April 2021

Citation: El Zein H, Bou Dagher-Kharrat M (2021) New records of vascular plants for the flora of Lebanon: a rare species rediscovered after seventy years, *Daphne pontica* L. (Thymelaeaceae), and three new occurrences, *Atropa bella-donna* L. (Solanaceae), *Circaea lutetiana* L. (Onagraceae), and *Euonymus latifolius* (L.) Mill. (Celastraceae). Check List 17 (2): 655–667. https://doi.org/10.15560/17.2.655

Introduction

Lebanon is located along the eastern coast of the Mediterranean Sea, and its flora belongs to the Holarctic floristic kingdom and is at the borders of three floristic regions: the Saharo-Sindian region, the Mediterranean region and the Irano-Turanian region (Takhtajan 1986; Zahran 2010). However, many elements of the Euro-Siberian region also occur in Lebanon, including species from the Euxinian and Hyrcanian provinces (Browicz 1989; Akhani et al. 2010). This is the case of the four species belonging to the genera *Atropa* L., *Circaea* L., *Euonymus* L., and *Daphne* L. presented here.

The genus *Atropa* L. is distributed from Western Europe to the Himalaya. *Atropa bella-donna* L. is a Euro-Siberian element native to Europe, North Africa, and

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western Asia (Davis et al. 1965; Rita and Animesh 2011). Although present in most European countries, *A. belladonna* is only native to Albania, Austria, Belgium, Bosnia and Herzegovina, Britain, Bulgaria, Corsica, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy (including Sardinia and Sicily), Kosovo, Montenegro, the Netherlands, North Macedonia, Poland, Romania, Slovenia, Spain, Switzerland, south-western Russia, and Crimea (Tutin et al. 1972). It is naturalized in the other countries. In North Africa, it also occurs in the mountainous regions of the Rif and Middle Atlas in Morocco, and of the Tell Atlas in Algeria (Butcher 1947). In western Asia, it is present in Turkey (Davis et al. 1965), the Caucasus, northern Iran (Ashtiani and Sefidkonb 2011), and western Syria (Mouterde 1984). In Lebanon, it was observed in various areas of Wadi Jhannam.

The genus *Circaea* comprises eight species (14 taxa) that are distributed in the Holarctic kingdom throughout moist, broad-leaved evergreen, deciduous, coniferous temperate and boreal forests between 25° and 65°N from sea level to elev5000 m elevation. *Circaea lutetiana* L. *sensus stricto* is a Euro-Siberian element that occurs in Europe, North Africa and western Asia (Post and Dinsmore 1932; Debazac 1959; Davis et al. 1965; Tutin et al. 1972; Boufford 1982, 2005; Boufford et al. 1990; Wagner et al. 2007). The closest populations to Mount Lebanon are located in the Nur Mountains in Turkey (previously known as Amanus) and in the extreme north of the Syrian Coastal Mountain Range, in Qastal Maaf and in the Froulok Forest in the Baer-Bassit region (Mouterde 1970; Post and Dinsmore 1932).

The genus *Euonymus* L. includes approximately 130 species, mostly shrubs, and sometimes small trees, distributed in Asia, Oceania, Europe, North Africa, Madagascar, and North America (Funston 2008). The centre of diversity of the genus is located in Asia, especially in Japan, China, and in the Himalaya, with 118 species, compared to only four in Europe (Blakelock 1951). In Turkey and Syria, the family is uniquely represented by the genus *Euonymus* (Post and Dinsmore 1932; Davis et al. 1965; Mouterde 1970). *Euonymus latifolius* (L.) Mill. is a Euro-Siberian element (Davis et al. 1965; Zohary 1973) naturally occurring in mountainous areas in Europe, North Africa, and western Asia. In Europe, it is present in the perialpine regions of Austria, France, Germany, Italy, Slovenia, and Switzerland (Rameau et al. 1999); in south-central and south-eastern Europe, namely in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Kosovo, Montenegro, North Macedonia, Romania, Serbia, and Crimea (Tutin et al. 1972; Burescu 2010); and in Spain, where it is rare (Gutiérrez et al. 2004; Pinedo Valero et al. 2004). In North Africa, it occurs in Talassemtane National Park in the Rif region and the Middle Atlas in Morocco (García Cardo and Sánchez Melgar 2007), as well as the Tell Atlas in Algeria (Yahi et al. 2008). In western Asia, it is present in the Caucasus (Lachashvili et al. 2017), northern Iraq (Gunal 2003), north-western Iran (Noirfalise et Djazirei 1965; Ejtehadi et al. 2015), Turkey, and north-western Syria. In Turkey, it occurs mainly on cool slopes in the mountainous regions of Marmara and Pontus on the south coast of the Black Sea, but also locally in other regions, such as Van in the Eastern Taurus (Davis et al. 1965; Gunal 2003). The closest Turkish populations to Lebanon are in the Taurus Mountains on Akher Dagh around Kahramanmaraş and the Nur Mountains. In Syria, it was collected once around the Shatha pass in the Syrian Coastal Mountain Range in the Latakia Governorate (Mouterde 1970). For a century, *E. latifolius* has also grown as an ornamental shrub in many parks and gardens in Western Europe and Scandinavia, where it has become naturalised in some countries, such as Belgium and the UK, as a result of birds distributing seeds into natural habitats (Champluvier et Renard 1985; Lambinon et al. 2004).

The genus *Daphne* L. contains over 90 species over Asia, Europe, and North Africa (Sovrlić and Manojlović 2017; Moshiashvili et al. 2020). In Lebanon, two species occur: *Daphne oleoides* Schreb. and *Daphne pontica* L. (Mouterde 1970). The latter species is an Euxinian element (Browicz 1989), occurring in south-eastern Bulgaria (Ivanova and Vladimirov 2007), Turkey, Syria, Lebanon, Caucasus, and northern Iran (Davis et al. 1965; Klein and Lacoste 1989; Eskandari et al. 2019). The populations of *D. pontica* L. in Syria and Lebanon were previously considered to be *Daphne libanotica* Mouterde, a separate species endemic to the Syrian coastal range and to Mount Lebanon. Thought to be extirpated in Lebanon 70 years ago, it was rediscovered in 2014 elsewhere at Baskinta, in the district of Metn, and then in 2020 at Wadi Jhannam, in the district of Minie-Danniye.

As for most of the Mediterranean region, landscapes in Lebanon have been modified by human activities since millennia (Blondel 2006; Blondel et al. 2010; Vernet 1990). Due to a tumultuous history and poor spatial planning, the natural areas in Lebanon have been largely degraded. A few mountainous areas have been spared and still shelter well-preserved habitats which remain understudied, such as the valley of the Assi River (Wadi Nahr el-Assi) in Baskinta (Metn District) and the valley of Wadi Jhannam (Minie-Danniye District). This is where *Atropa bella-donna* L., *Circaea lutetiana* L., *Daphne pontica* L., and *Euonymus latifolius* (L.) Mill. were found during floristic surveys (Fig. 1). The distribution of each taxon is here described and their presence on Mount Lebanon is discussed.

Methods

The surveys were carried out in Nahr el-Assi (Metn District) during 2014 and 2015 and in Wadi Jhannam (Minie-Danniye District) in spring to winter of 2018–2020. The valley of Nahr el-Assi in Baskinta is located 10 km eastward from the Sannine summit, the second-highest point in the Mount Lebanon range (2,628 m a.s.l.). The valley of Wadi Jhannam is located 13 km north of Qornet es-Sawda, the highest summit of the range (3,088 m a.s.l.).

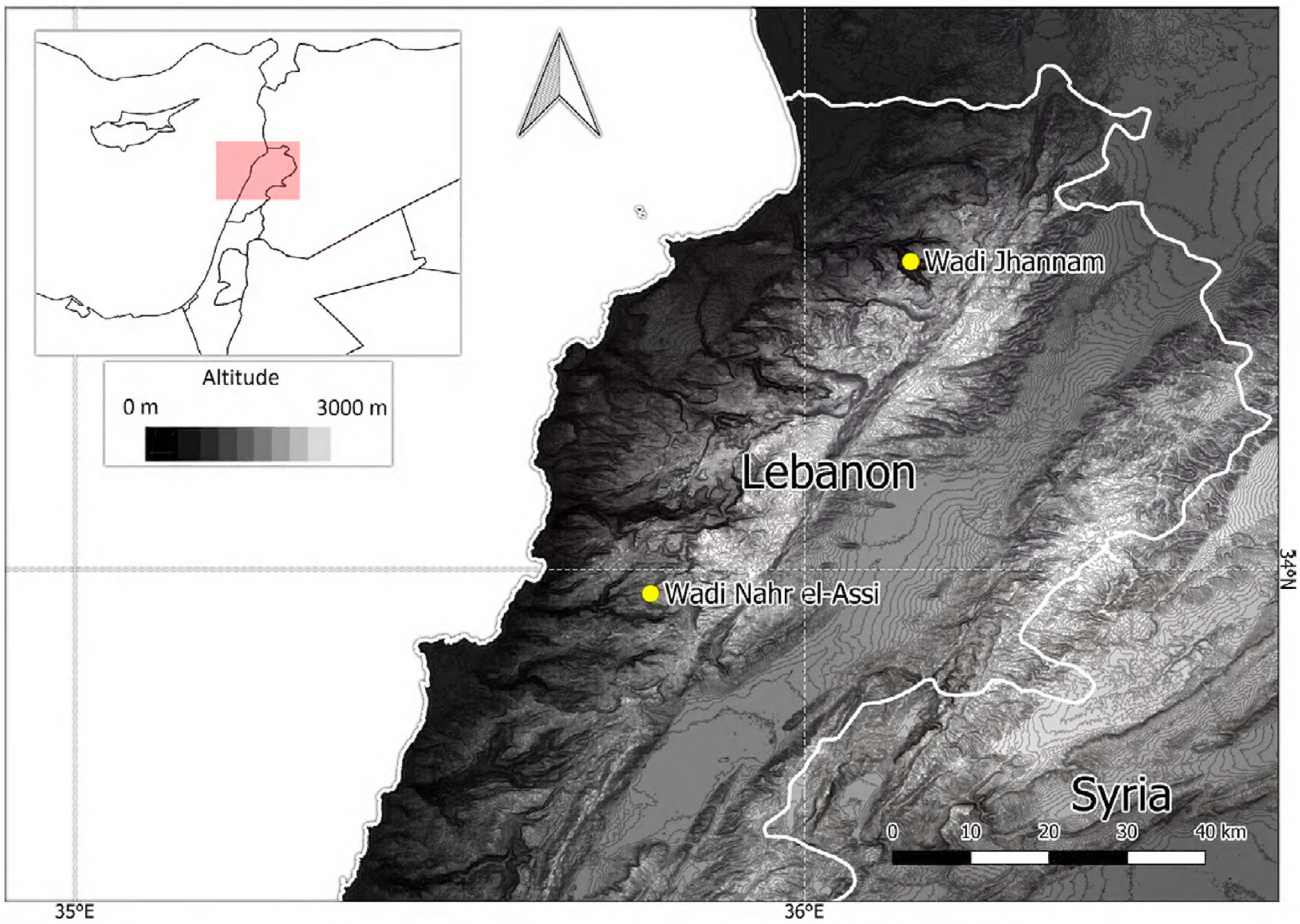

Figure 1. Geographic situation of the two sites of study in Mount Lebanon, Wadi Jhannam and Wadi Nahr el-Assi.

Plant species were identified using four floras: the floras of Lebanon (Mouterde 1970, 1984), Syria, Palestine, and Sinai (Post and Dinsmore 1932), Turkey and the East Aegean islands (Davis et al. 1965), and Europe (Tutin et al. 1972). Familial classification and synonyms were updated in accordance with the information sourced from the International Plant Names Index (INPI 2020), the World Checklist of Selected Plant Families (WCSP 2020). The maps were prepared with QGIS software (QGIS Development Team 2020) using layers freely available on the DIVA-GIS website (2020). The distribution maps were realised by mapping occurrences for each taxon from bibliographic references, recent observations provided by Global Biodiversity Information Facility (GBIF 2020), and new records reported in this study. The occurrences from GBIF were cleaned using the CoordinateCleaner package (Zizka et al. 2019) on R software (2020). The data were then verified and manually compiled. For each species, at least one individual per site of study was sampled. The collected specimens have been deposited at the Post Herbarium in the American University of Beirut (BEI). Occurrences of the collected specimens were summarised in a table and published on GBIF (El Zein 2021). The assessment of *D. pontica* was made following the guidelines of the International Union for Conservation of Nature (IUCN) Red List categories and criteria (IUCN Standards and Petitions Committee 2019). Only *D. pontica* was assessed due to its limited range.

Results

***Atropa bella-donna* L.**, Sp. Pl.: 181. 1753 (Linnaeus 1753)
Figures 2, 3

New records. LEBANON – North Governorate • Minie-Danniye district, Qemmamin, Wadi Jhannam; 34° 25.04′N, 036°08.52′E; 830 m a.s.l.; 7.VI.2018; fl. and fr.; H. El Zein; BEI-HELB 0517 • same locality; 34°23.34′N, 036°10.02′E; 1475 m a.s.l.; 7.VI.2019; fl. and fr.; same collector; BEI-HELB 0518.

Description. Perennial herbaceous, 50–100 cm tall, stems glandular-pubescent above. Leaves alternate, shortly petiolate, entire, broadly ovate, acuminate, often asymmetric, pubescent. Flowers axillary, solitary. Calyx green, campanulate, deeply 5-lobed, 10–14 mm long, stellate during fructification reach up 40 mm in diameter. Corolla tubular-campanulate, brownish violet with purple veins, pale yellow for some individuals, 25–35 × 10–15 mm, short lobes. Stamens with yellow anthers, included inside corolla. Fruit a globose black berry, 1–2 cm in diameter.

Habitats. The species was observed in open and sunny places on rocky, calcareous, well-drained substrates and in humid atmosphere within riparian woodlands or next to springs, from 800 to 1500 m (Fig. 4). It showed a preference for tilted rocks or steep slopes and was never present on flat surfaces with other competitive species. The riparian woodland was characterised by the presence of

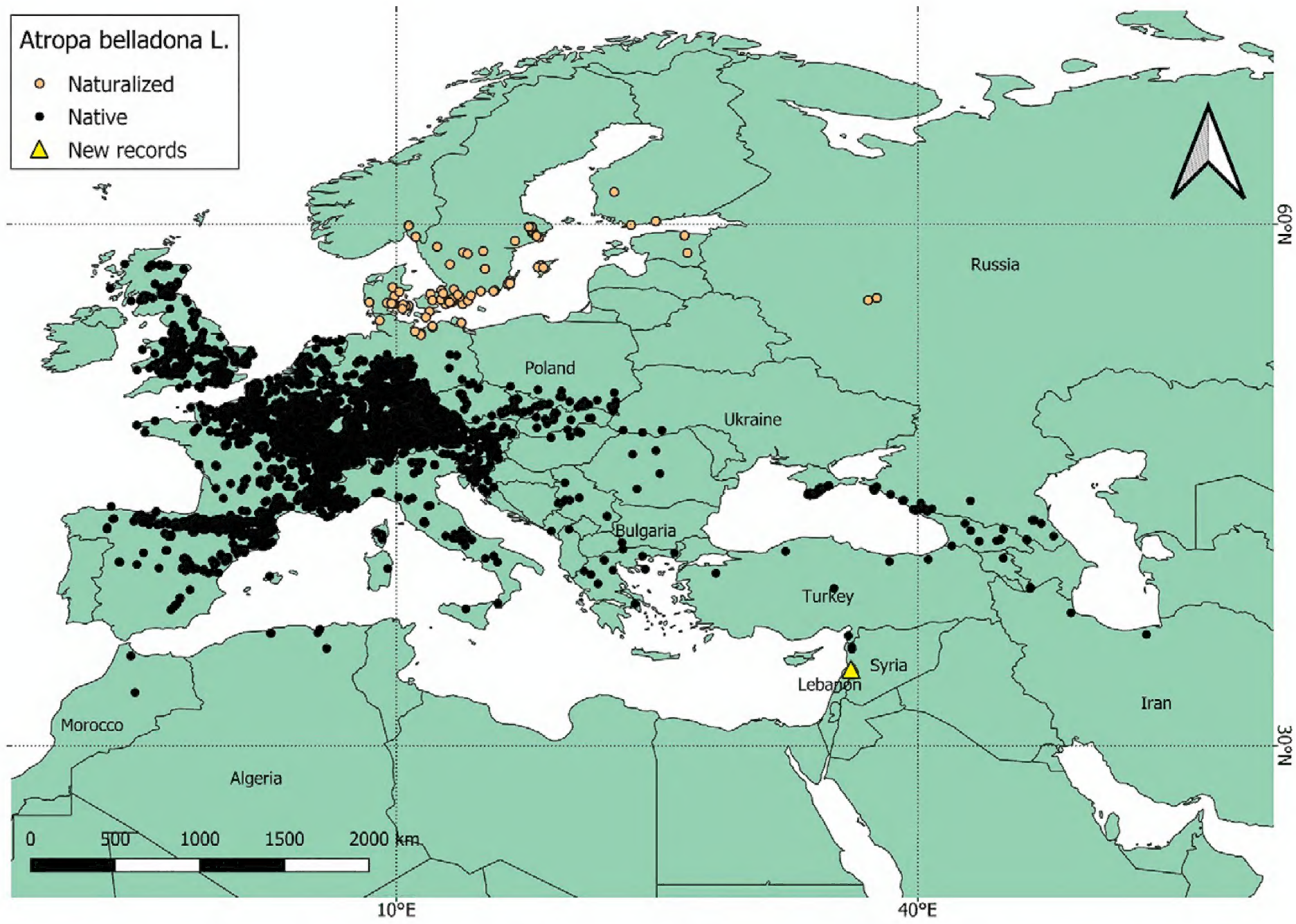

Figure 2. Distribution map of *Atropa bella-donna* L. highlighting the records known prior to this work throughout its range (Butcher 1947; GBIF 2020a), in Europe (Tutin et al. 1972), Turkey (Davis et al. 1965), Iran (Ashtiani and Sefidkonb 2011), Syria (Mouterde 1984), and the new records reported here from Lebanon.

typical trees, namely *Platanus orientalis* L., *Laurus nobilis* L., and *Salix alba* L. It was often accompanied with vines and herbaceous species that have hygrophyte behaviour in the Mediterranean regions, such as *Hedera helix* L., *Rubus sanctus* Kuntze, *Campanula peregrina* L., *Eupatorium cannabinum* L., and *Adiantum capillus-veneris* L. *Atropa bella-donna* was also observed two times on travertine, along with mosses.

***Circaea lutetiana* L.,** Sp. Pl.: 9. 1753 (Linnaeus 1753)
Figures 5, 6

New records. LEBANON – Mount Lebanon Governorate • Metn district, Baskinta, Wadi Nahr el-Assi; 33°57.92′N, 035°47.42′E; 1260 m a.s.l.; 12.IX.2014; fl. and fr.; H. El Zein; BEI-HELB 0471 • same area; 33°57.84′N, 035°47.38′E; 1310 m a.s.l.; 28.VII.2020; fl. and fr.; same collector; BEI-HELB 0519.

Description. Perennial herbaceous, 15–60 cm tall. Leaves opposite, obscurely and remotely denticulate, ovate, acuminate, slightly cordate or rounded at the base, 4–10 cm, petiole 1–10 cm. Flowers in terminal raceme, 2-merous, Calyx green, free sepals. Corolla with 2-lobed petals, white, or sometimes pinkish. Stamens 2. Stigma 2-lobed. Fruit obovoid, 3–4 × 2–3 mm, indehiscent, covered with bristles, 1- or 2-seeded.

Habitat. The two populations were found in woodlands located on a shady slope with humid to wet soil and thick substrate of organic matter. The bedrock was of ferruginous sandstone. The altitude varied from 1260 to 1310 m. The surroundings were sparsely covered with low hygrophyte trees and shrubs, namely *Fraxinus ornus* L., *Platanus orientalis*, *Ostrya carpinifolia* Scop., *Rhododendron ponticum* L., and *Salix libani* Bornm.

***Euonymus latifolius* (L.) Mill.** Gard. Dict., ed. 8: Euonymus no. 2. 1768 (Miller 1768)
Syn: *Euonymus europaeus* L. var. *latifolius* L., Sp. Pl., ed. 1: 197. (Linnaeus 1753).
Figures 7, 8

New records. LEBANON – Mount Lebanon Governorate • Metn district, Baskinta, Wadi Nahr el-Assi; 33° 57.92′N, 035°47.40′E; 1280 m a.s.l.; 12.IX.2014; fr.; H. El Zein; BEI-HELB 0520 – North Lebanon Governorate • Minie-Danniye district, Qemmamin, Wadi Jhannam; 34° 25.04′N, 036°08.52′E; 830 m a.s.l.; 7.VI.2018; fr.; H. El Zein; BEI-HELB 0356.

Description. Shrub or small tree up to 3 m. Leaves opposite, obovate to elliptic, 5–10 × 3–6 cm, finely serrate, acuminate, glabrous. Flowers organised in cymes. Calyx green, 4 or 5 rounded sepals. Corolla with 4 or 5 elliptic petals, white greenish, sometimes purplish. Fruit broadly winged capsule, 15–20 mm of diameter, dehiscent, 4 or

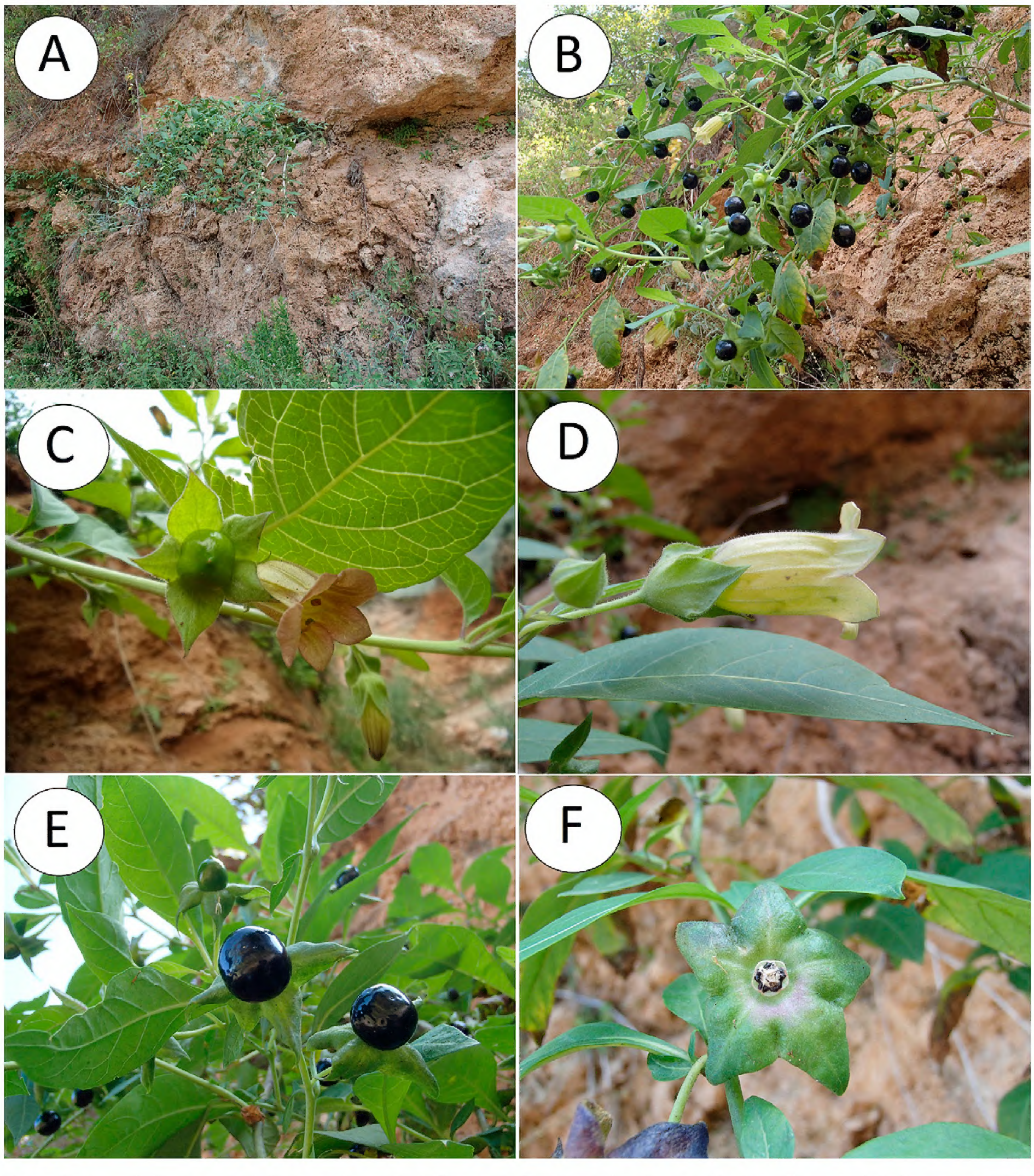

Figure 3. *Atropa bella-donna* L. **A, B.** General view. **C, D.** Flowers. **E.** Fruits. **F.** Calyx after fructification. Photographs taken in June 2018, September 2020 and November 2020 in Wadi Jhannam by HE.

5 locular, bright pink, containing seeds covered with bright orange aril.

Habitat. In Wadi Nahr el-Assi, two individuals were observed in deciduous woodland on a steep slope with moist soil and thick litter of organic matter on sandstone bedrock. It was accompanied with the same shrubs and trees present in the habitat where *Circaea lutetiana* was collected. The site was difficult to access due to its steepness. In Wadi Jhannam, it was observed in two types of habitat (Fig. 4), both cool woodlands with thick litter. The first type of habitat was the riparian woodland, previously described, where one individual of *Atropa bella-donna* was collected. The second type was a mixed woodland on slopes with limestone bedrock dominated by deciduous trees and conifers, such as *Fraxinus ornus*, *Ostrya carpinifolia*, *Aria umbellata* (Desf.) Sennikov & Kurtto, *Abies cilicica* (Antoine & Kotschy) Carrière, and *Cedrus libani* A.Rich.

***Daphne pontica* L.**, Sp. Pl.: 357. 1753 (Linnaeus 1753)
Figures 9, 10

New records. LEBANON – Mount Lebanon Governorate • Metn district, Baskinta, Wadi Nahr el-Assi; 33°57.93′N, 035°47.37′E; 1270 m a.s.l.; 12.IX.2014; fr.;

Figure 4. Habitats A. Deciduous mountainous woodland in Wadi Nahr el-Assi in May 2015 where *Circaea lutetiana* L., *Euonymus latifolius* (L.) Mill. And *Daphne pontica* L. were recorded. B. Riparian mountainous woodland in Wadi Jhannam in June 2018 where *E. latifolius*, *D. pontica*, and *Atropa bella-donna* L. were recorded. C. Mixed mountainous woodland in Wadi Jhannam in June 2020 where *E. latifolius* was recorded. Photographs by HE.

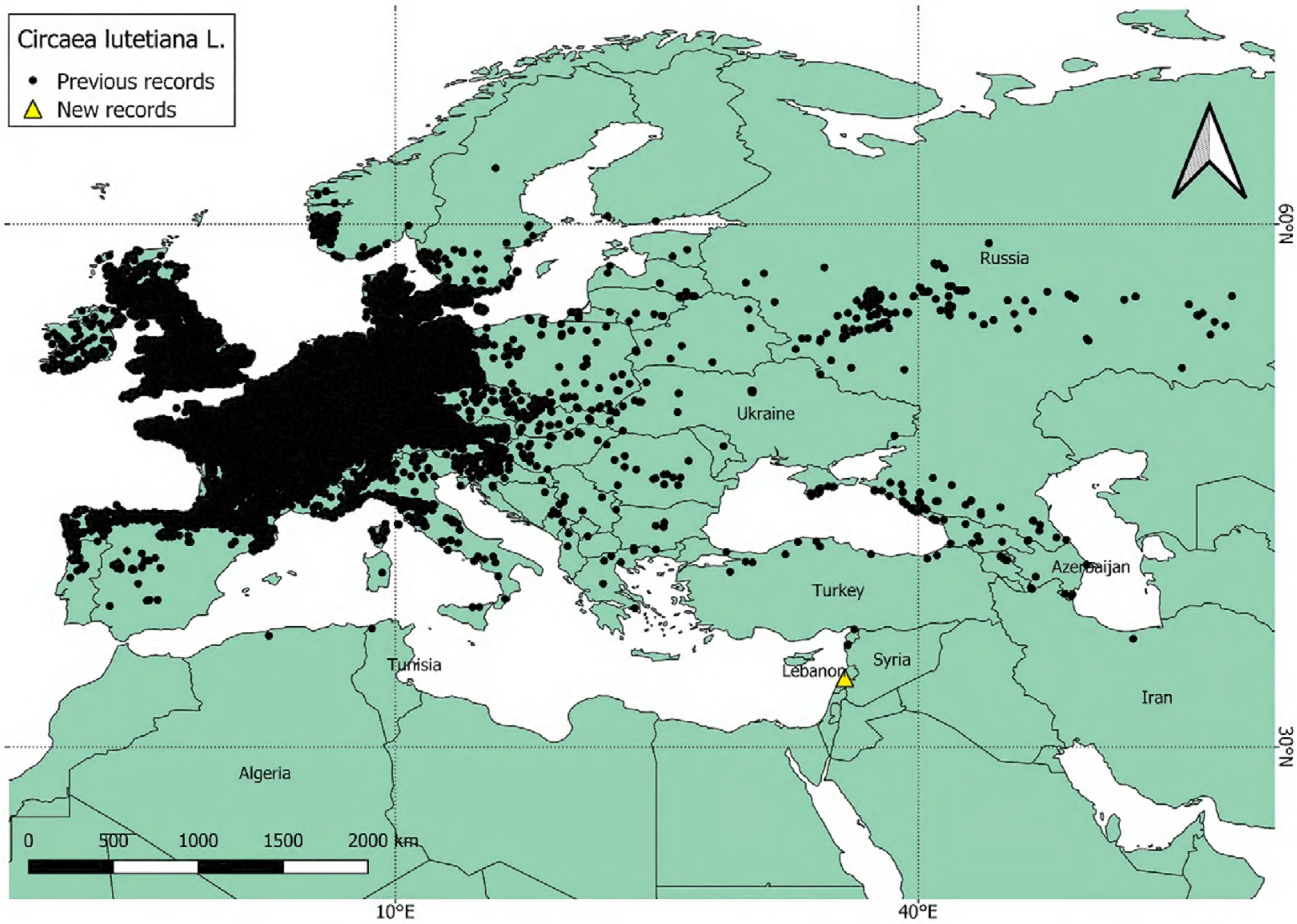

Figure 5. Distribution map of *Circaea lutetiana* L. highlighting the records known prior to this work throughout its range (Bufford 1982; GBIF 2020b), in Russia and Caucasus (Skvortsov 1979), Tunisia (Debazac 1959), Turkey (Davis et al. 1965), Syria (Post and Dinsmore 1932; Mouterde 1970), and the new records reported here from Lebanon.

H. El Zein; BEI-HELB 0033 • same locality; 33°57.93′N, 035°46.98′E; 1170 m a.s.l.; 10.VIII.2020; fl.; same collector; BEI-HELB 0477 – North Lebanon Governorate • Minie-Danniye district, Qemmamin, Wadi Jhannam; 34°25.04′N, 036°08.52′E; 830 m a.s.l.; 8.X.2020; fr.; same collector; BEI-HELB 0508.

Description. Sub-shrub 30–60 cm tall. Leaves evergreen, alternate, subsessile, entire, elliptic to obovate, acute, 4–8 × 1.5–3.0 cm, glabrous. Flowers axillary. Perianth yellowish-white, 4 acute tepals, with recurved tips. Stamens with yellow anthers, included inside corolla. Fruit ovoid one-seeded berry, 7–8 mm in diameter, black, glabrous.

Habitat. In Wadi Nahr el-Assi, the species occurred in two types of habitat (Fig. 4), riparian woodland and deciduous woodland, always on substrate with an important layer of organic matter covered by a thick litterfall, on sandstone bedrock. In the riparian woodland, *Platanus orientalis*, *Laurus nobilis*, *Salix alba*, *Hedera helix*, and *Rubus sanctus* were accompanying. The deciduous woodland had the same composition that the one where *Circaea lutetiana* and *Euonymus latifolius* were collected. In Wadi Jhannam, it was collected in the same site of the riparian woodland where *A. bella-donna* and *E. latifolius* were collected.

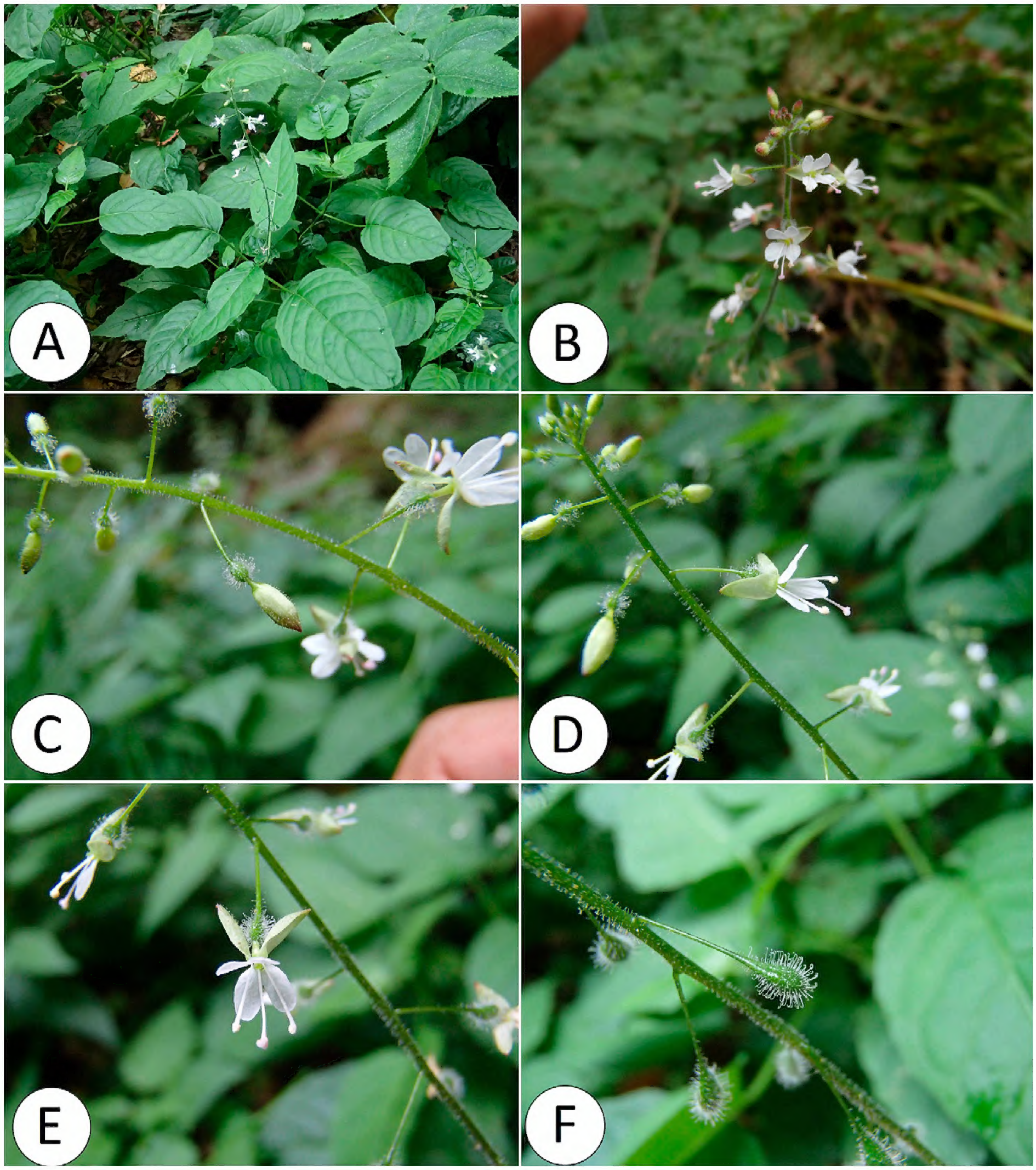

Figure 6. *Circaea lutetiana* L. **A.** General view. **B.** Inflorescence. **C.** Floral bud. **D.** Flowers, Lateral view. **E.** Flowers, Frontal view. **F.** Fruits. Photographs taken in September 2014 and July 2020 in Wadi Nahr el-Assi by HE.

Conservation status. *Daphne pontica* is nationally assessed in Lebanon as Critically Endangered, B1ab(iii) but is yet not globally assessed.

Discussion

These new records contribute to a better characterisation of the affinities of the Lebanese flora in the region. Although part of Saharo-Sindian, Mediterranean, and Irano-Turanian floristic regions (Takhtajan 1986; Zahran 2010), the flora of Mount Lebanon is characterised by a significant Euro-Siberian affinity. These four taxa are relics of the vegetation during the Quaternary glaciation. During the Quaternary period, the gradual cooling and drying of the climate caused the extinction of many species. Mediterranean plants persisted through this period in isolated glacial refugia that are recognized to be the sources for future re-colonization. Mount Lebanon has acted as a refugium during periods of Quaternary glaciation (Fady-Welterlen 2005; Bou Dagher-Kharrat et al. 2007; Svenning et al. 2008; Médail and Diadema 2009; Douaihy et al. 2011). Climatic oscillations caused the ranges of plant species to contract and then expand again as the climate warmed. Since Mount Lebanon range has

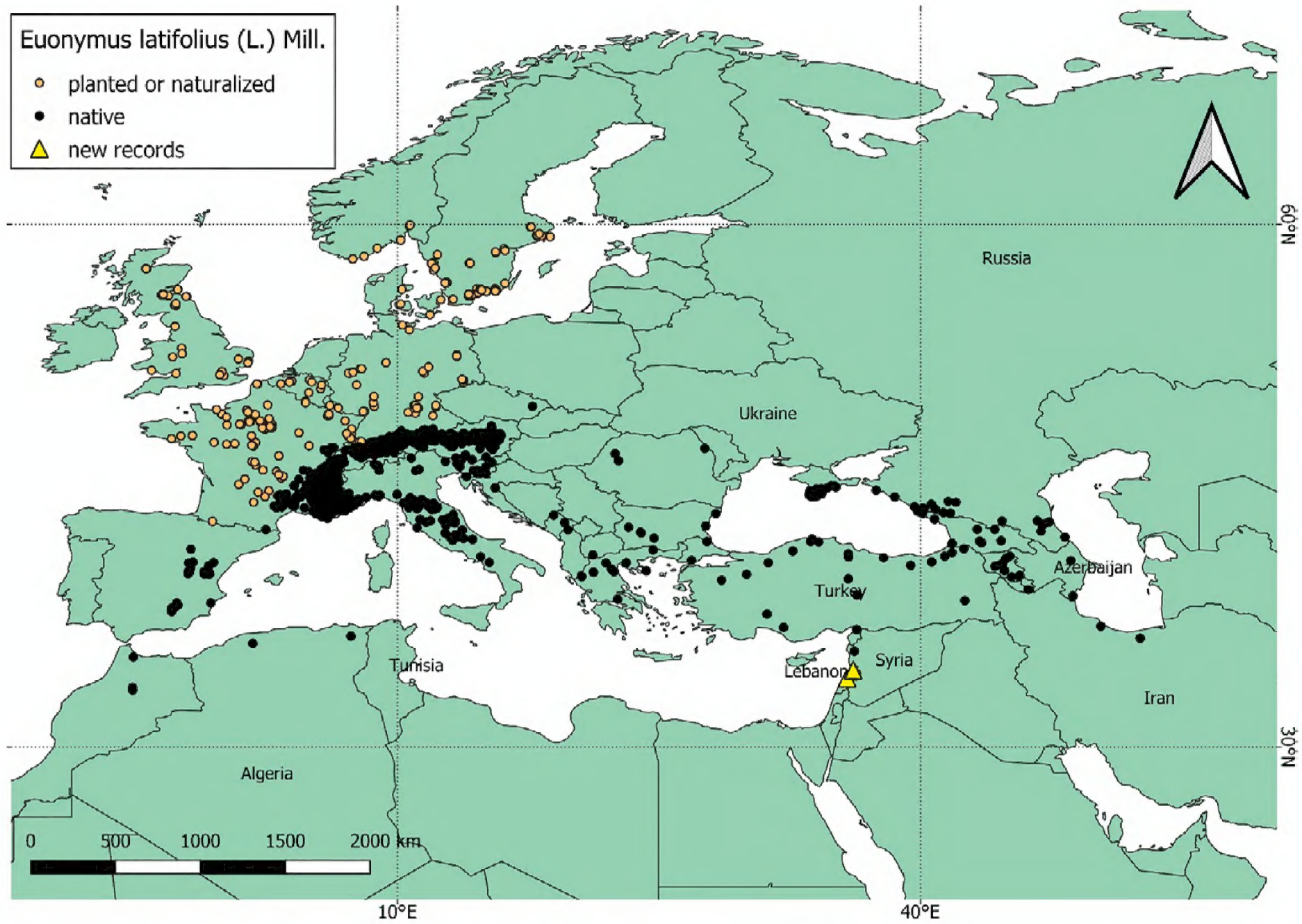

Figure 7. Distribution map of *Euonymus latifolius* (L.) Mill. highlighting the records known prior to this work throughout its range (Tutin et al. 1972; Rameau et al. 1999; Meusel and Jager 2013, GBIF 2020c), in Romania (Burescu 2010), Spain (García Cardo and Sánchez Melgar 2007), Morocco (Gutiérrez et al. 2004), Algeria (Yahi et al. 2008), Turkey (Davis et al. 1965; Gunal 2003), Iran (Noirfalise and Djazirei 1965; Ejtehadi et al. 2015), Caucasus (Lachashvili et al. 2017), Syria (Mouterde 1970), and the new records reported here from Lebanon.

a north–south orientation, species are thought to migrate to the north during warm periods and to the south during cooling periods along the range. Lebanon mountain range is, however, interrupted by deep valleys created by snowmelt runoff and rainfall drainage. Some species persisted in the deep valleys where they found an suitable niche to equivalent northern latitudes. Thus, Lebanon constitutes today the southernmost limit for species such as *Cedrus libani* (Bou Dagher-Kharrat et al. 2007), *Juniperus excelsa* M.Bieb. (Douaihy et al. 2013), and *Abies cilicica* (Awad et al. 2014; Sękiewicz et al. 2015). Such rear edge populations may be of particular conservation value as significant components of intraspecific biodiversity or sources of evolutionary innovation and persistence during environmental change (Hardie and Hutchings 2010). This is the case of *Circaea lutetiana* and *Daphne pontica*, which reach the southernmost edge of their ranges in Mount Lebanon (Figs. 5, 9). Though *Atropa bella-donna* and *Euonymus latifolius* reach their southernmost edge of range in Morocco, Mount Lebanon constitutes the south-easternmost limits of their ranges and, therefore, the Lebanese populations of these species have the same conservation value as any edge population (Figs. 2, 7).

The four taxa probably had larger areas of occurrence in Mount Lebanon, but habitat fragmentation and deforestation have reduced their presence. *Daphne pontica* was historically rare in Lebanon and was collected several times from two localities in the district of Keserwan, between Maarab and Dlebta and between Chahtoul and Aaramoun. This species was thought to have been extirpated in Mount Lebanon by the late 1930s. On the latest sample collected on 1 November 1938 (specimen G00190856 - no. SIB 162232/1), Paul Mouterde left a note explaining that the species was extirpated from the known localities, without mentioning the reason of its extirpation, and that this specimen was the only one collected with mature fruits (CHG 2020). Since then, it was not officially reported in Lebanon until 2014, in Wadi Nahr el-Assi, where 14 individuals were observed. In Wadi Jhannam, two individuals were observed in 2020; however, there is a strong probability that others are extant in the valley, as many steep areas have not yet been visited. *Daphne pontica* was nationally assessed as Critically Endangered due to the small size of its population (16 individuals), its limited extent of occurrence (12.5 km²) and area of occurrence (12 km²), and the continuing degradation of its natural habitats by urbanization and road construction. Apart from *D. pontica*, the other three species, *Atropa bella-donna*, *Circaea lutetiana*, and *Euonymus latifolius* are reported here for the first time in Lebanon. *Atropa bella-donna* and *C. lutetiana*

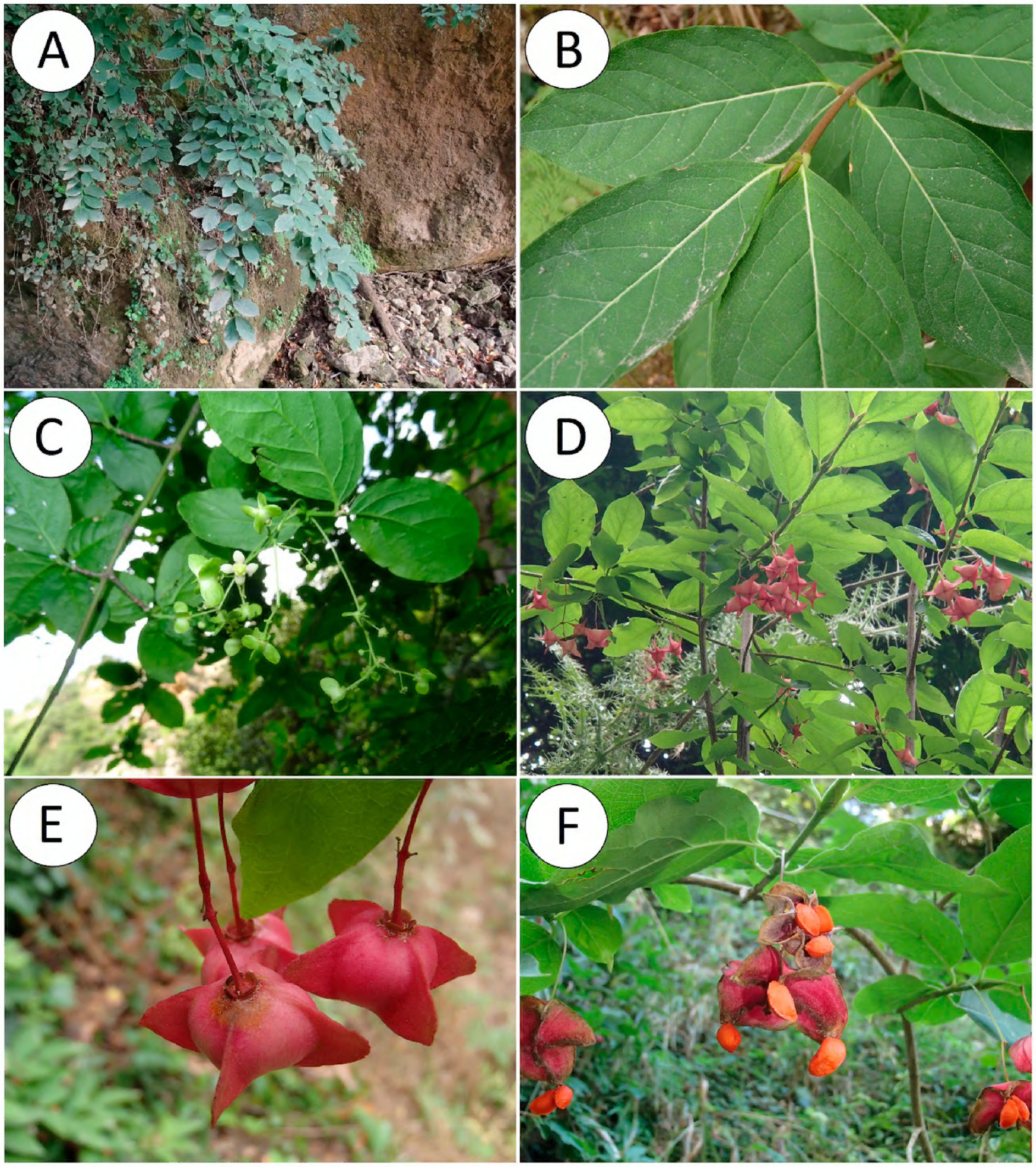

Figure 8. *Euonymus latifolius* (L.) Mill. **A.** General view. **B.** Leaves. **C.** Flowers. **D–F.** Fruits. Photographs taken in July 2015 in Wadi Nahr el-Assi and July 2020 in Wadi Jhannam by HE.

were found in different valleys. Five individuals of *A. bella-donna*, each by itself, were observed in separate areas of Wadi Jhannam, while three patches of *C. lutetiana* were found in Wadi Nahr el-Assi. *Euonymus latifolius* was found in both valleys. It had a larger presence in Wadi Jhannam, where 49 individuals were counted in 12 different locations, compared to Wadi Nahr el-Assi, where two individuals were observed.

The four taxa share the same habitat types, namely mountainous, riparian woodlands and deciduous or mixed woodlands between altitudes of 830 and 1475 m. These habitats are present in restricted areas in Mount Lebanon. Riparian woodlands constitute a narrow and linear habitat type which is always alongside high summits in steep-sided valleys that run to the Mediterranean Sea. This topography is important biogeographically, as it hinders the dispersal of species between valleys. Preserved deciduous and mixed woodlands occupy a relatively small and scattered area in Mount Lebanon, as they are exclusively restricted to mountainous areas between approximately 1200 and 1600 m (Abi-Saleh and Safi 1988). The rarity of the four taxa can be explained by the their spatially limited habitats. The simultaneous presence of three species, *Atropa bella-donna*, *Daphne*

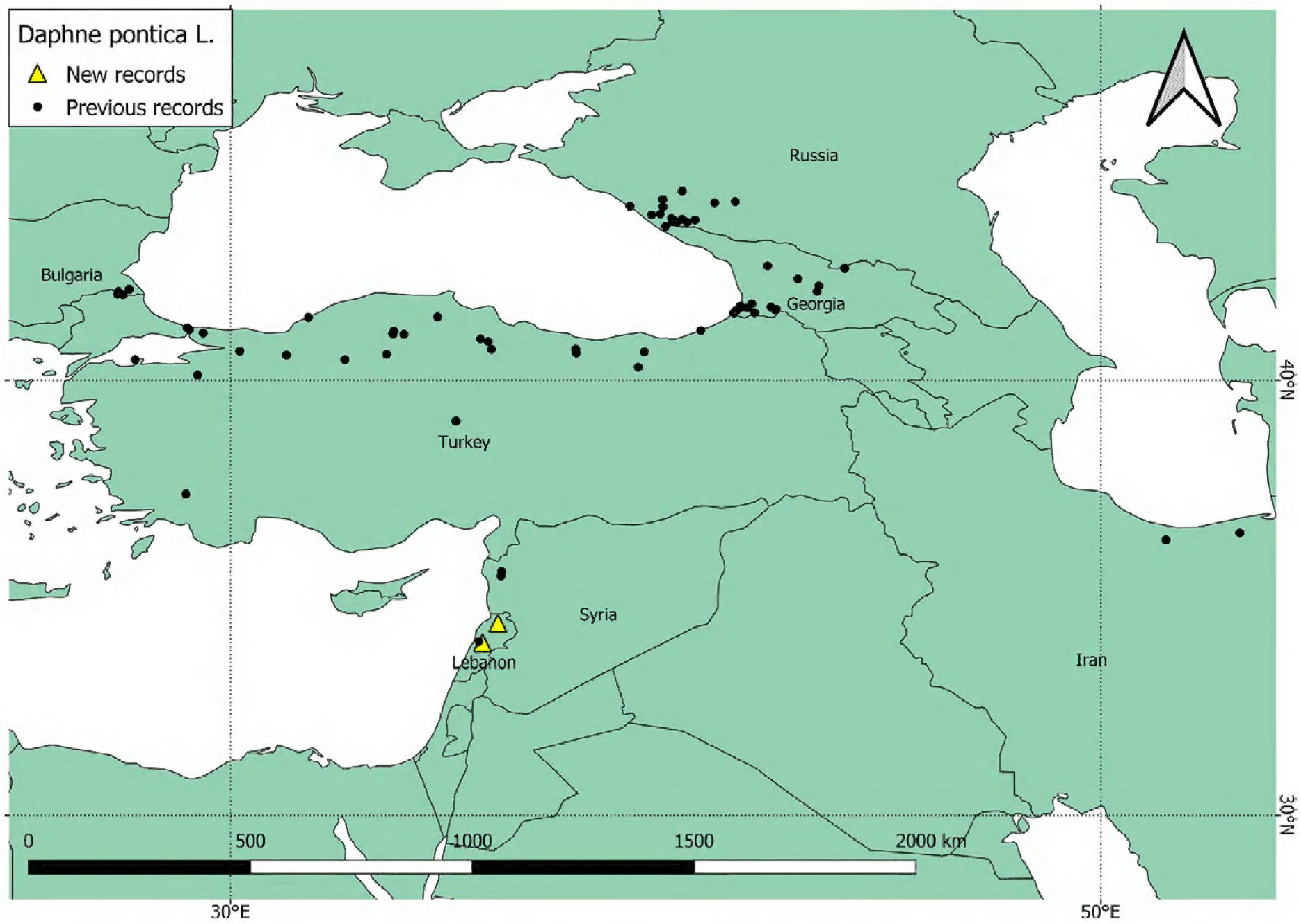

Figure 9. Distribution map of *Daphne pontica* L. highlighting the records known prior to this work throughout its range (GBIF 2020d), in Bulgaria (Ivanova and Vladimirov 2007), Caucasus and Iran (Klein and Lacoste 1989; Eskandari et al. 2019), Turkey (Davis et al. 1965), Syria and Lebanon (Mouterde 1970) and the new records reported here from Lebanon.

pontica, and *Euonymus latifolius* in one part of the riparian woodland in Wadi Jhannam is noteworthy. This highlights the remaining floristic richness of Mount Lebanon, although importantly degraded by human activities.

In Turkey and Syria, the four species were also reported to occur in similar habitats, namely shady banks and places in deciduous forests or mixed forests (Davis et al. 1965; Mouterde 1970, 1984). *Daphne pontica* occurred in forest of *Fagus–Abies cilicica*, *Corylus*, and *Rhododendron ponticum* on limestone and igneous rock (Davis et al. 1965). In Lebanon, *D. pontica* was only found on sandstone and not exclusively in habitats associated with *R. ponticum*. However, the latter is also a Euxinian element, and its association with *D. pontica* similar to that in Turkey constitutes significant evidence of the affinities between the Levantine montane flora and the Euro-Siberian floristic region (Davis et al. 1965; Browicz 1989).

These new occurrences and the rediscovery of *D. pontica* is the result of the inaccessibility and underexploration of some areas in Lebanon. Their presence is possible in other valleys of Mount Lebanon where similar microhabitats exist. Mount Lebanon constitutes the edge of their distribution in the Levant, and conservation measures should be taken to preserve these populations. Many plant species are currently seriously threatened in Lebanon, and more studies are needed to assess their conservation status and to implement effective conservation plans for their natural habitats. The creation of plant micro-reserves (PMR) to protect the species (Laguna et al. 2004) was the initial objective of the study carried out in Wadi Nahr El-Assi. Following the decision of landowners, the site could not be legally classified as a PMR but will be preserved from urbanisation (Bowall 2018). The possibility of creating a larger protected area in Wadi Jhannam is still under discussion.

Acknowledgements

The work carried out in Wadi Nahr el-Assi in 2014 and 2015 was supported by the Critical Ecosystem Partnership Fund under grant 63257. We are indebted to M. Michel Ayoub, the land owner in Wadi Nahr el-Assi, for facilitating the access to the field and for his kind cooperation to preserve this unique piece of wilderness.

The work carried out in Wadi Jhannam was supported by the Mohamed bin Zayed Species Conservation Fund in 2019 under the project 180519099 and by the Rufford Foundation in 2020 under project 32258-1. We are indebted to Carla Khater, Mohammad Souhail Al-Zein, and Mohammad Zahed Taleb for their help and encouragement for this research, to Manuel Melendo Luque, Robert Forsyth and the anonymous reviewer for revising the manuscript with attention. Their comments

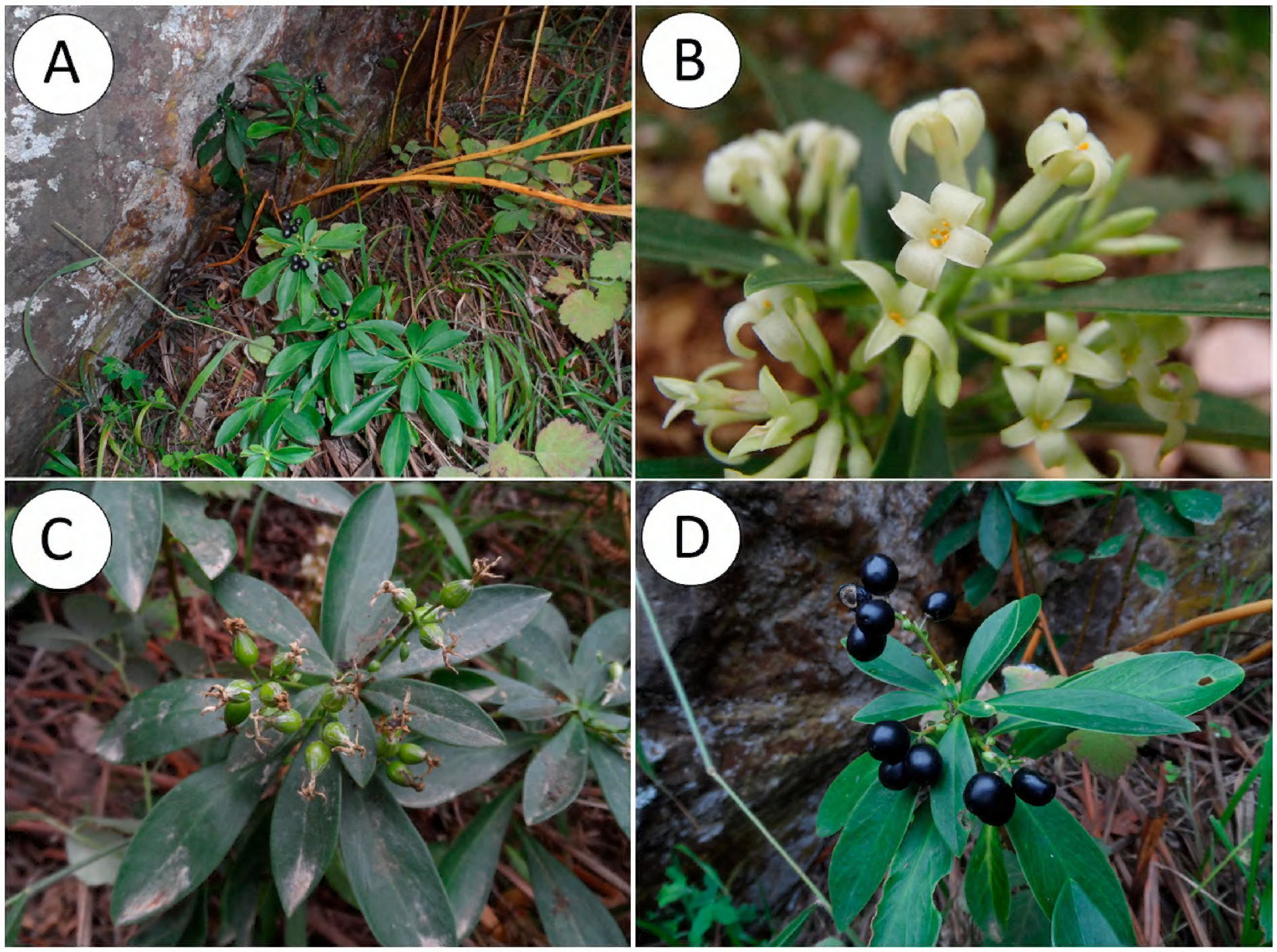

Figure 10. *Daphne pontica* L. **A.** General view. **B.** Flowers. **C.** Immature fruits. **D.** Fruits. Photographs taken in Wadi Nahr el-Assi in September 2014 and July 2020 by HE.

were so useful. Many thanks to Nadda Sinno and Reem Kawtharani for their help in receiving and mounting the specimens for the Post Herbarium in Beirut. Many thanks to Anna Lamb for revising the paper as a native English speaker.

Authors' Contributions

MBK designed the study in Wadi Nahr el-Assi and insured its funding. She revised and approved the manuscript. HE designed the study in Wadi Jhannam and insured its funding, performed the fieldwork, identified the taxa, collected the specimens, wrote the first version of the manuscript, and prepared the distribution maps.

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